(3-345 LINAC)

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"LINAC FOR ION BEAM ACCELERATION"

Claims

1. Linac for ion beam acceleration, **characterised** by the fact of comprising:
i) at least one couple of a first and a second accelerating structure (8) aligned on the same axis, resonating on a H-type standing wave electromagnetic field, each one housing a plurality of coaxial drift tubes (15), supported by stems and reciprocally separated to form a respective gap (20) accelerating the ion beam, where the external extremity (8A) of said first accelerating structure is the input of the pre-accelerated, collimated and focused ion beam, and the external extremity (8B) is the output of the higher energy ion beam,
ii) an interposed coupling structure (9), or if necessary a modified coupling structure (9A) to be connected to an RF power generator (11), acting as a bridge for the RF power flow between adjacent accelerating structures (8), coaxial, resonating in a standing wave TEM-type cavity mode, composed of two coaxial cylinders, if necessary linked to a vacuum system (13) and including, if necessary, one or more quadrupoles (18), whose length is appropriate to maintain synchronism of the acceleration, being linked to said first and second accelerating structures (8), with their respective internal extremity (8C) through annular terminations (10), present at both extremities

of said accelerating structures (8) and allowing the regulation of the electromagnetic field on the axis of each said accelerating gap (20),

iii) wherein the working frequency is superior to 100 MHz.

2. Linac according to claim 1, **characterised** by the fact that inside said accelerating structures (8) said drift tubes (15) are supported by $m \geq 1$ thin radial stems (16,17) reciprocally rotated on a circumference of π / m.

3. Linac according to claim 1, **characterised** by the fact that such annular terminations (10) are designed in the shape of annular chamber having an inner diameter corresponding to the outer diameter of said accelerating structures (8) and an outer diameter about twice the inner diameter, where said terminations in the shape of annular chamber (10) are open on a circumference corresponding to their inner diameter, while on their outer surface have coupling apertures (14) at specific positions.

4. Linac according to claim 1, **characterised** by the fact that the base module (7), composed of said first and second accelerating structures (8) and of said interposed coupling structure (9A), connected to an RF power generator (11), and if necessary equipped with one or more quadrupoles (18), is foreseen to be modularly extended to form extended modules (7A) comprising an always odd number n of coupling structures (9, 9A), if necessary equipped with one or more quadrupoles (18), and a number $N = n + 1$ of accelerating structures (8).

5. Linac according to claim 1, **characterised** by the fact that the length of said drift tubes (15) and of said accelerating gaps (20) increases so that the

distance between the centres of neighbouring said accelerating gaps (20) is about an integer multiple of the particle half wavelength ($\beta\lambda$ / 2).

6. Linac according to claim 1, **characterised** by the fact that said plurality of drift tubes (15) housed inside said accelerating structures (8) is positioned in order to determine the formation of the resonant π-mode.

7. Linac according to claim 1, **characterised** by the fact that each base module (7), or each said extended module (7A), forms a series of coupled resonators oscillating in the π /2 mode.

8. System of ion beam acceleration, **characterised** by the fact that it comprises, sequentially, an ion source (1), if necessary a pre-accelerator injector (2), if necessary a low energy beam transport line (3), a linac (4) for ion beam acceleration up to the energy required for a particular application, according to one or more of the claims 1 to 7, and furthermore if necessary a high energy beam transport line (5), and an area or device (6) where the accelerated beam is used.

9. Linac according to claim 1, **characterised** by the fact that the working frequency is in the range 100 MHz – 0.8 GHz.

10. Linac according to claim 1, **characterised** by the fact that the working frequency is superior to 0.8 GHz.

11. Method for accelerating a ion beam in a linac, wherein the ion beam, preliminary collimated, pre-accelerated, focused and if necessary steered in

a low energy beam transport line (3), is injected into a linac (4) according to one or more of the claims 1 to 10 in which:

- the beam acceleration is obtained by radiofrequency electric fields whose level is substantially constant in all said accelerating gaps (20) belonging to the same module (7, 7A) foreseen in the linac (4), said module or modules (7, 7A) present a single input (12) for the RF power, for each module (7, 7A) foreseen, where said single input (12) for RF power is connected with a single modified coupling structure (9A),
- the transverse focusing is obtained with magnetic fields produced by quadrupoles (18), preferably provided between two or more accelerating structures (8),
- furthermore at the linac (4) output, the accelerated ion beam is if necessary steered in a higher energy beam transport line (5) in the area or to the device (6) where it is to be used.

12. Method according to claim 11, **characterised** by the fact that the output beam energy is modulated by varying the input RF power, and the intensity of the linac output beam is modulated by the ion beam parameters at the linac input and by the beam dynamics.

13. Use of a linac or a system comprising a linac according to one or more of claims 1 to 10 for medical applications.

14. Use of a linac or a system comprising a linac according to one or more of claims 1 to 10 for fundamental and applied research and related applications.

15. Use of a linac or a system comprising a linac according to one or more of claims 1 to 10 for the production of average beam currents superior to 10 μA for research and related applications.